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Segment diffusion in polymers confined in nanopores: A fringe-field NMR diffusometry study

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Abstract

The dynamics of polymer chains confined in artificial tubes formed by the pores of a nanoporous material should display all the features predicted by the reptation model, provided that the polymer/wall interaction does not lead to adsorption effects. We have studied the segment diffusion behavior of linear polyethyleneoxide in the molten state in pores of well characterized cross-linked polyhydroxyethylmethacrylate matrices. These "semi-interpenetrating networks" were prepared in such a way that (10±2) nm thick cylindrical pores completely filled with polyethyleneoxide were produced. The measuring technique was fringe-field NMR diffusometry. The results are compatible with a power law for the mean squared displacement, □r2□ ∝t-0.4±0.1Mw -0.8±0.2, where t is the diffusion time and Mw is the weight average molecular mass. This is to be compared with the limiting law □r2□∝t-1/2Mw -1/2 predicted by de Gennes, Doi, and Edwards for region III, that is, τR≪t≪τd of the tube/reptation model. In the frame of the experimental accuracy the conclusion is that the reptative diffusion mechanism applies to linear polymer chains of sufficient length relative to the diameter of the confining pores. ©1999 The American Physical Society.